TECHNICAL AND ECONOMICAL FEASIBILITY OF BENEFICIATING (ABU-TARTUR) PHOSPHATE DEPOSIT

By

Nabil El-Sayed Abdel Rahman El-Sharkawy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE
In
Mining Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:
Technical and Economic Feasibility of Beneficiating Abu-Tartur Phosphate Deposit

Key Words:
Beneficiating plant; phosphate concentrate; mining engineering; phosphoric acid; magnesium

Summary:

Abu-Tartur plateau are exploited by open cast of a layer ranges in thickness between 3.9 to 4.5 meters. The average P_2O_5 content is 24%. The impurities are mostly iron and magnesium carbonates with low silica content. Therefore, the beneficiation step is mandatory to produce a phosphate concentrate for merchant grade phosphoric acid and phosphate fertilizers.

In this study, five flow sheets with different setup and machineries were tested and compared to the current flowsheet at the Misr phosphate company. Each flowsheet was tested technically in terms of grade and recovery of the produced concentrate and economically in terms of the cost of the produced ton of concentrate with the required grade. A concentrate containing 30% P_2O_5 was obtained at a cost ranges from 183 to 212 Egyptian pounds per ton. The main result is the same concentrate can be produced by about 30 pounds less in cost by selection of the proper flowsheet and machinery.

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My thanks and best wishes to all members of - Misr Phosphate Company – (New Valley phosphate project)

Dedication

I dedicate this work to my family and my friends for their love, support and encouragement which gave me the strength to overcome many obstacles.

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Nomenclature

Montmorillonite:

Is an aluminum-rich clay mineral of the smectite group, containing some sodium and magnesium.

Sulphides:

Is a binary compound of sulfur with another element or group.

Shale:

Is a soft, finely stratified sedimentary rock that formed from consolidated mud or clay and can be split easily into fragile slabs.

Ankerite :

Primarily is a king of iron not limited to also with combinations of calcium, magnesium, manganese carbonate mineral of the group of Rhombohedral with the formula $Ca(Fe,Mg,Mn)(CO_3)_2$.

Gangue:

Is a worthless material surrounding, covering or mixed with ore - the wanted material - in our case in phosphate deposit and mining.

Abstract

Abu-Tartur plateau lies 50 km west of El-Kharga city. Currently, Misr phosphate company mining activities are using open cast of a layer ranges in thickness between 3.9 to 4.5 meters. The average P_2O_5 content is 24%. The impurities are mostly iron, magnesium carbonates and silica. It is clear that the beneficiation is a mandatory step to reach the concentrate with phosphoric acid grade.

Beneficiation studies have been conducted to test several beneficiation flow sheets for producing phosphate concentrate for merchant grade phosphoric acid. No doubt that, for industrial plant, during its lifetime, it witnessed various additions and removal of some units, which produced several set-up or flow-sheets. In this research work, five flow sheets were chosen for detailed investigation. The overall goals of This study is to evaluate and compare the Techno-Economic Feasibility of These different Design in order to determine to optimum Beneficiation Flow-Sheet technically in terms of grade and recovery and economically in terms of the cost of the produced ton with the required grade in terms of P_2O_5. The studied flowsheets for annual production 600000 tons are:

Main flowsheet: include all equipment in ore dressing plant for reaching high production where using non-weather ore. Size of feed -6 cm, size of production between -2mm to -0.08mm, yield was about 58% and recovery was about 72%. The produced concentrate contains P_2O_5 31% with ton of concentrate cost 212 LE

Flowsheet 1: Similar to the main flowsheet except the withdrawal of magnetic separation unit. Using Size of feed -3 cm, the yield was about 68.5% and P_2O_5 recovery was about 83%. The produced concentrate contains P_2O_5 30% with ton of concentrate cost 190 LE.

Flowsheet 2: Similar to the flowsheet 1 except additional of magnetic separation unit. Using weathered ore, Size of feed -6cm, the yield was about 62% and P_2O_5 recovery was about 78%. The produced concentrate contains 31.5% P_2O_5 with ton of concentrate cost 209 LE.

Flowsheet 3: Similar to the flowsheet 2 except the withdrawal of magnetic separation and cell attrition, the yield was about 66% and P_2O_5 recovery was about 83%. The produced concentrate contains 31.5% P_2O_5 with ton of concentrate cost P_2O_5 188 LE.

Flowsheet 4: Similar to the flowsheet 3, Size of feed -3cm, yield about 68.9% and P_2O_5 recovery about 87%. The produced concentrate contains 31.1% P_2O_5 with ton of concentrate cost P_2O_5 188 LE.

Flowsheet 5: Similar to the flowsheet 4, Size of feed -1cm, yield about 76% and P_2O_5 recovery about 91% the produced concentrate contains 30% P_2O_5 with ton of concentrate cost P_2O_5 182 LE.

As a summary of this study, concentrate containing 30% P_2O_5 was obtained at a cost ranges from 182 to 212 Egyptian pounds per ton. The main result is the same concentrate can be produced by about 30 pounds less in cost by selection of the proper flowsheet and machinery.

Chapter 1
Introduction

Phosphates, in the form of fertilizers are essential in the agricultural sector. They are also very important constituents in animal feed stocks and in food and other chemical industries. About 95% of the world phosphate rock production is consumed in fertilizer industry.

Economic recovery of phosphates is limited to naturally concentrated phosphate mineral deposits, [1].

Occasionally natural concentrations are enough to be used as mined Generally if the ore is of low grade it must be concentrated for economic utilization thus beneficiation so techniques are used for concentrating the ore of mine phosphates.

More than 40 countries around the world produce phosphate rock. In 2015 [1] the world phosphate production reached 196 MT out of which 180 MT were produced by sixteen major phosphate producing countries, These countries arranged in descending order of their production capacities are: USA, Morocco, China, Russia< Tunisia, Jordon, Brazil, Syria, South Africa, Egypt, Australia, Senegal, India, Togo and Canada [1].

Only 16 MT are produced by all other countries.

In Egypt phosphate ores are mined from Abu-Tartur plateau Western Desert. The phosphate seam is spread all over the plateau covering an area of about 1200 Km^2 Only one tenth of that area had been geologically explored by means of 375 surface drill holes. Indicating the presence of about 715 MT of phosphate reserves [2, 3]. The average seam thickness is about 3.3m.

The present exploitation is restricted to an area $14km^2$ with reserves about 120 MT can be extracted by open cast methods. The ore currently exploited as a run of mine phosphate (R-O-M) contain an average of 25% P_2O_5 average is convoyed to a beneficiation plant to be concentrated to 31% P_2O_5 concentrate. The project is carrying out lots of modifications to rectify and improve the situation especially in beneficiation plant. Then the whole concentrate quantity should be manufactured to fertilizers when the Abu-Tartur chemical fertilizer becomes a reality. Especially the project is well served by a complete network of infrastructure including rally-ways, power supply, water supply, roads and housing [4, 5].